CONCRETE LABORATORY LTD

FINAL REPORT

FABRICATION OF LARGE CONCRETE CYLINDERS FOR DETERMINING RESISTANCE OF CONCRETE TO ICE ABRASION AND IMPACT

(FOR OF THE PROGRAM OF THE FEDERAL PANEL ON ENERGY R & D)

MIX DESIGN,
CONCRETE PROPERTIES
AND
PREPARATION FOR SPECIMEN
FOR ABRASION TESTING

DSS FILE NUMBER	:	09SQ.23440-9-9208
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CANMET PROJECT NUMBER	:	30.37.02
CANMET SCIENTIFIC AUTORITY	:	G.G. CARETTE

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MICROMEDIA

QUALITY CONTROL - MATERIALS TESTING
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CONCRETE LABORATORY LTD

October 22, 1990.

Supply and Services Canada
Science Branch
11C1, Place du Portage, Phase III
11, Laurier Street
Hull (Quebec)
K1A 0S5

Care of : Mr Robert McMillan
Science Contracting Officer

Your Reference n° : 09SQ.23440-9-9208
Our file n° : S6236
Report n° : 03B (1090)

Object : Proposal N° 09SQ.23440-9-9208
Fabrication of Concrete Cylinders
for Determining Resistance of Concrete
to Ice Abrasion and Impact

Dear Sir,

Please find here-in our final report regarding this project.

Sincerely,

André Bisaillon, Eng.

AB/fh

p.j.

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FABRICATION OF LARGE CONCRETE CYLINDERS FOR DETERMINING RESISTANCE OF CONCRETE TO ICE ABRASION AND IMPACT

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1. OBJECTIVE

The present report covers the preparation of large size specimen with four non-air entrained concrete mixtures to be proportioned to provide 15, 25, 35 and 45 MPa compressive strength at 28 days using local normal weight limestone and CSA type 10 cement. The large size specimen are cylinders 30 mm in diameter and 500 mm long with a 87 mm steel shaft in the central axis. For each strength two specimen were cast; one with a smooth surface and one with a rough surface.

The concrete was tested for compressive strength and elastic modulus and the results are given in this report with the characteristics of the fresh concrete.

2. WORK SCHEDULE

Our contract was awarded on the 26 of February. The specimen were to be delivered to Fleet Technology for the 6 of April. Since 28 days of curing were required this left less than 2 weeks to cast the specimen. To accelerate the work, a subcontract was given to Fleet Technology, a previous fabricator on a similar contract, to manufactured the steel shaft and reinforcing steel required for the cylinders.

The shaft were received on Monday the 19 of March and we schedule the casting of the specimen for the 21, 23, 26 and 28 of March. Unfortunately the casting of the specimen had to be cancelled on March 21 because the diameter of the shaft had been change and that they would not fit in our moulds. In the few days that followed we had several conversation with the representative of Fleet Technology to find the most appropriate solution. Finally we were instructed to have the mould remachined to fit the diameter of the shafts. We located a subcontractor that accepted the work and delivered the moulds on the 24 of April. The casting of the specimen was done as shown on table 1.

3. CASTING OF TESTS SPECIMEN

Concrete mixes for all types of concrete were prepared in 0,16 m^3 batches, using mix design formulae shown in table 2.

All materials were pre-weighed and placed in sealed bags. Before mixing, humidity content of the aggregates was measured and all materials were re-weighed.

The materials were batched according to CAN/CSA A23.2-2C.

Concrete was cast in steel moulds in which a steel shaft and reinforcing steel (photo 1) were secured by means of a hole at the bottom of the mould and a steel collar above the mould (photo 2).

Two types of plastic lining were installed in the moulds to simulate smooth (photo 3) and rough (photo 4) surface textures.

All joints in the mould were sealed with a caulking (photo 5) to insure uniformity of the surface (photo 6) and prevent loss of paste.

Concrete was placed in 15 cm layers and each layer-vibrated with a 20 mm diameter internal vibrator. After vibration of each layer the mould was struck wigh a hammer around its outside circular surface to evacuate air bubles on the inside surface.

From each batch two 500 mm x 300 mm diameter specimen were cast one of each texture for abrasion and impact testing. Fifteen 300 mm x 150 mm diameter were also moulded from the same batch of concrete for testing at 3, 7, 28 and 91 days with three cylinders being tested at each age. The testing of the extra cylinders was done at the some age as the abrasion test on the large specimen.

After 24 hours the concrete specimen were stripped of the mould, placed in the curing room, at 23°C and 100% relative humidity (according to CSA CAN3-A23.2-3C) for 28 days after which they were shipped to Fleet Technology.

TABLE 1

SCHEDULE

TEST N°	STRENGTH	SPECIMEN N°	DATE OF CASTING	EXPECTED DATE OF SHIPPING
6236-06	15 MPa	06-A	04/27/90	05/21/90
		06-B	04/27/90	05/21/90
6236-07	25 MPa	07-A	04/30/90	05/21/90
		07-B	04/30/90	05/21/90
6236-08	45 MPa	08-A	05/02/90	05/21/90
		08-B	05/02/90	05/21/90
6236-09	35 MPa	09-A	05/04/90	05/21/90
		09-B	05/04/90	05/21/90

TABLE 2

BASIC MIX FORMULAE

(AS DETERMINED IN TASK 3)

Mix n°	06	07	08	09
Concrete strength, MPa	15	25	45	35
Nominal size coarse aggregate, mm	---------- 20 mm ----------			
Type of aggregate	---------- normal weight ----------			
Quantities				
Cement, kg	255	345	570	420
Water, kg	190	190	200	190
Coarse aggregate, kg	1 000	1 000	1 000	1 000
Sand, kg	1 000	850	630	780
W/Cement	0,745	0,550	0,350	0,450
Slump, mm	---------- 80 mm ----------			
Air Content, %	---------- 6% ----------			
	3,0	2,5	2,0	2,5

4. PHYSICAL PROPERTIES OF AGGREGATES

4.1 Normal Weight Coarse Aggregates (Demix Quarry Laval)

	10 mm	14 mm	20 mm
Specific Gravity :	2,74	2,76	2,73
Absorption :	0,7%	0,4%	0,6%

4.2 Normal Weight Fine Aggregates (St-Gabriel de Brandon)

Specific Gravity : 2,69
Absorption : 0,7%
Fineness Modulus : 2,51

4.3 Sieve Analysis of Sand

SIEVE SIZE	% PASSING	CSA SPECIFICATION % PASSING
10	100	100
5	99	95-100
2,5	90	80-100
1,25	72	50-90
630	42	29-65
315	7	10-35
160	1	2-10
80	0,4	0-3

4.4 Sieve Analysis of Normal Weight Coarse Aggregate

SIEVE SIZE	% PASSING 32% 20 mm 50% 14 mm 18% 10 mm	CSA SPECIFICATION % PASSING
28 mm	100	100
20 mm	93	90-100
14 mm	65	-
10 mm	29	25-60
5 mm	4	0-10
2,5 mm	0,1	0-5

5. RESULTS OF TESTS ON THE CONCRETE

Date of casting	04/27/90	04/30/90	05/02/90	05/04/90
Concrete strength MPa	15	25	45	35
FORMULA (kg/m^3) 6236-	06	07	08	09
Cement	245	323	571	426
Water	183	190	206	193
Coarse agg. 20 mm	308	320	320	325
Coarse agg. 14 mm	480	499	501	508
Coarse agg. 10 mm	961	849	631	792
Sand	173	180	180	183
W/C	0,745	0,551	0,362	0,452
RESULTS				
Slump (mm)	60	120	120	110
Air content (%)	4,0	3,0	2,2	2,8
Temperature (°C)	20	21	20	21
Unit weight (kg/m^3)				
Theoretical	2350	2385	2400	2390
Fresh	2350	2360	2410	2427
14 days	2385	2384	2416	2414
Compressive Strength, MPa				
3 days	7,5	15,7	31,0	25,4
	7,7	15,9	34,1	25,4
	7,8	16,3	34,5	26,6
7 days	11,7	24,7	36,6	28,8
	12,9	25,9	37,3	29,2
	12,9	26,3	39,3	32,4
28 days	18,8	30,7	47,3	37,8
	19,5	32,0	48,3	40,0
	19,8	32,9	49,3	40,7
91 days	20,3	31,5	47,5	41,5
	20,8	33,7	49,8	42,8
	21,3	34,6	50,3	44,8
Extra cylinders	175 d	100 d	134 d	168 d
	23,5	34,0	49,8	42,7
	24,4	34,0	53,3	43,2
	24,6	36,0	55,4	45,3

5. RESULTS OF TESTS ON THE CONCRETE (CONT'D)

Modulus of elasticity, MPa X 10^6

28 days	29030	28830	30805	27135
	26450	31210	32240	32500
Average	27740	30020	31520	29820

Poisson's ratio

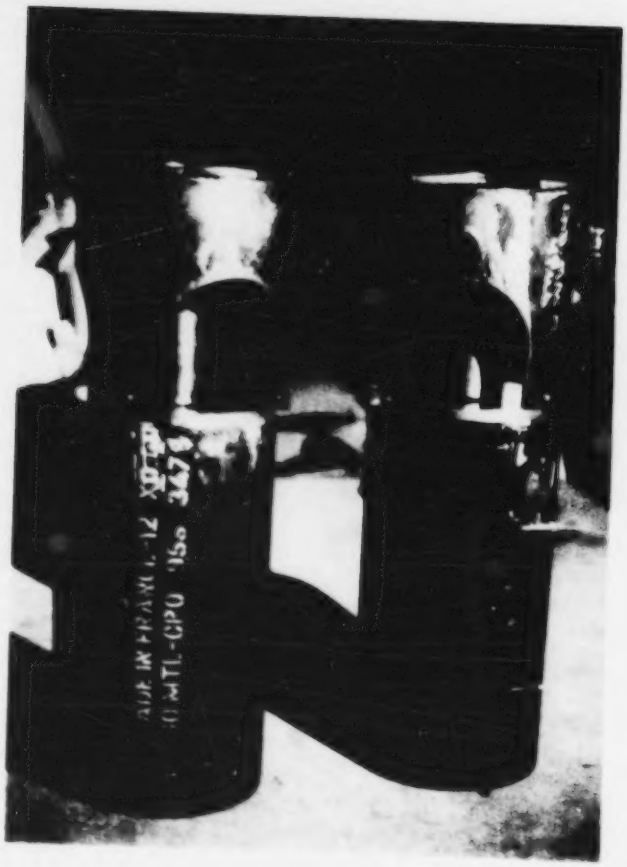
28 days	0,25	0,23	0,24	0,21
	0,23	0,21	0,26	0,26
	0,24	0,22	0,25	0,24

APPENDIX "A"

PHOTO NO 1

STEEL SHAFT AND REINFORCING STEEL

PHOTO NO 2



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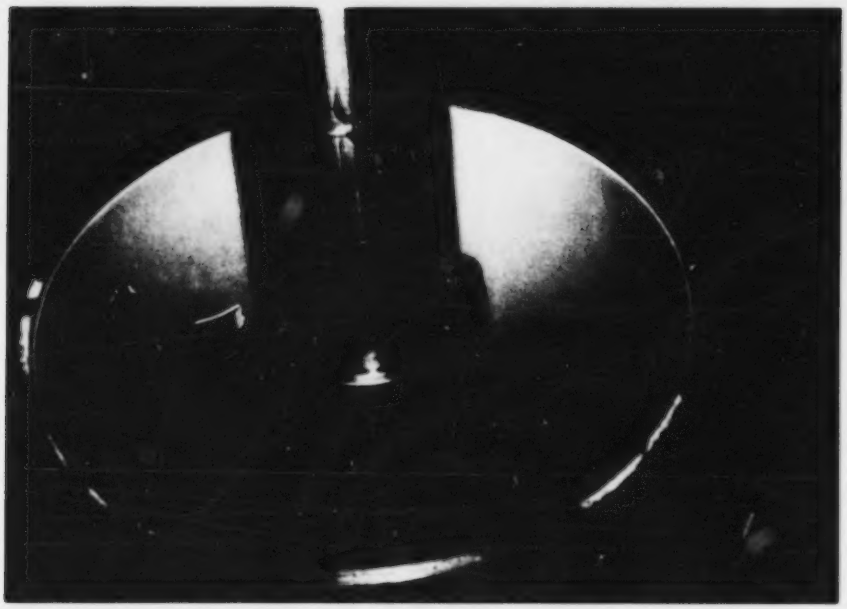
MOLDS WITH SHAFT SECURING DEVICE

PHOTO NO 3

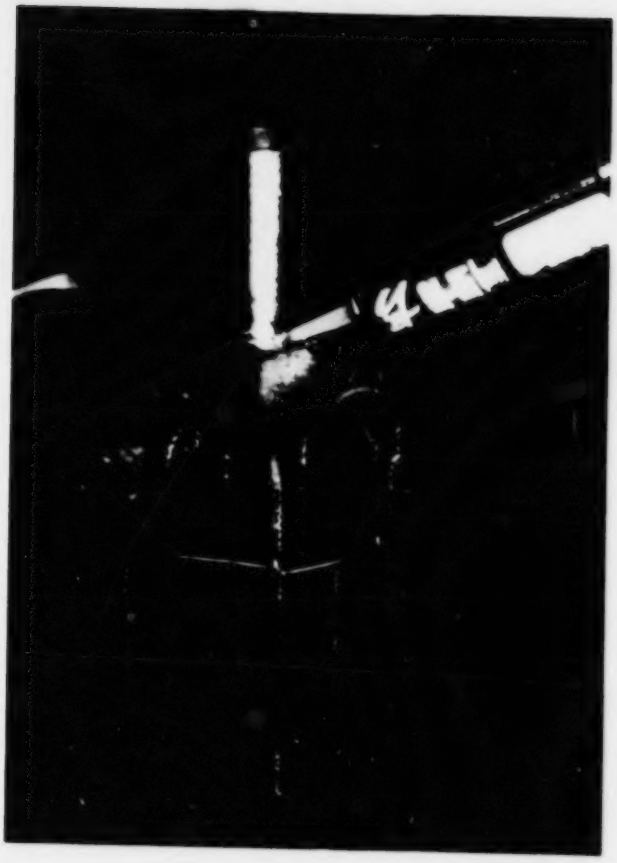


SMOOTH TEXTURE PLASTIC LINER

PHOTO NO 4

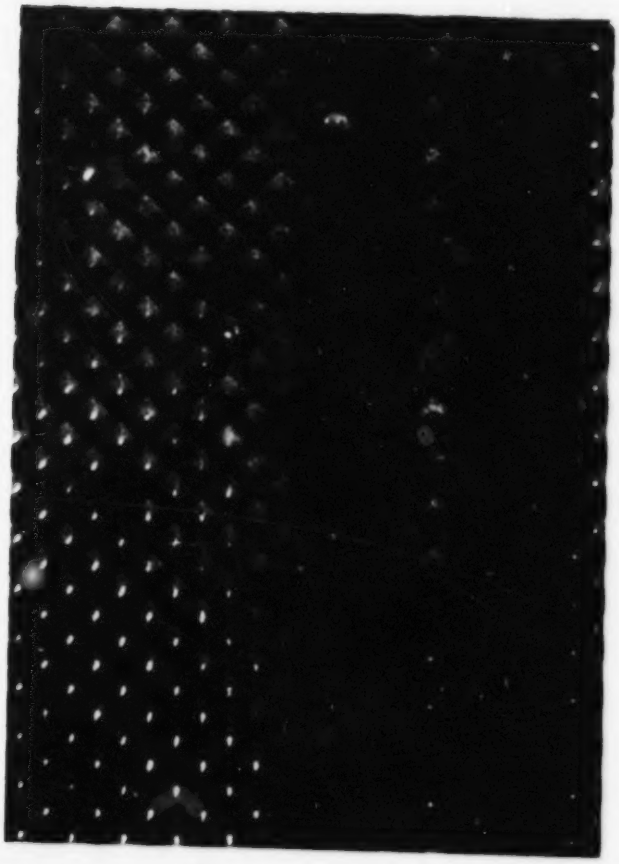
ROUGH TEXTURE PLASTIC LINER

PHOTO NO 5



APPLICATION OF SEALER ON SHAFT

PHOTO NO 6



TEXTURE AT MOLD VERTICAL JOINT